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Effect of Ginger on the Microbial, Organoleptic, Proximate Composition, Safety and Shelf Life of Smoked Tilapia Fish (*Oreochromis Niloticus*)

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ABSTRACT
Fish has been playing an important role in addressing nutritional and livelihood security of people in the developing countries. This work was carried out to assess the microbial qualities of ginger on the safety and shelf life of smoked tilapia fish (*oreochromis niloticus).*The microbial load counts (TVC, TCC and TFC cfu/g) and isolated microorganism were evaluated on smoked tilapia fish preserved for 0, 2, 4, 6 and 8 weeks with 5g of salt, ginger (natural preservatives) and untreated sample. Highest Bacteria Count (TVC) of 3.5×10^5 was recorded in salt sample at the 8 weeks of storage and highest fungi count (TFC) of 5.5×10^6 was recorded in untreated sample at week 2 of storage while highest coliform count (TCC) of 4.2×10^5 is recorded in untreated samples at week 2 of storage and the microorganism isolated from the samples showed that the highest number of microorganism species was recorded in untreated sample with 8 species of microbes while salt and ginger had 4 species of microbes each. The highest value (64.75%) of crude protein in proximate composition was recorded in ginger sample while the least was 20.32% in untreated sample. Sensory evaluation results show that all the samples were generally accepted by consumers except untreated sample. Statistical analysis shows a significant difference in the number of colonies formed between the groups at ($p < 0.05$). The preservative samples used in this work, reduced the microbial load, discourage quick spoilage, and encourage longer shelf-life of smoked tilapia fish.

Key words: smoked fish, microbial load, ginger and salt.

INTRODUCTION

Fish and fisheries products are among the most perishable commodities worldwide mainly due to microbial spoilage. About one-third of the world's food production is lost annually as a result of microbial spoilage. In fact, microbial activity is responsible for spoilage of most fresh and of several lightly preserved seafoods [1]. To prolong the shelf life of fish, it is preserved by many processes including sun drying, solar drying, canning and smoking among others. Dried fish is a major component of harvested fisheries in many countries including Nigeria. About 25 to 30% of the world fish catch is consumed in the dried, salted, smoked form or combination of these processes [2].

Smoking as a method of preservation produces commonly acceptable products since it imparts desirable colour and flavor. Smoked seafood products vary widely in microbial stability, but this depends on the nature and degree of severity of smoking. To ensure short time storage of dry fish that is safe from moulds and bacteria infestation, the moisture content must be less than 30% [3]. Spoilage of food products can be due to chemical, enzymatic or microbial activities.
Chemical deterioration and microbial spoilage are responsible for loss of 25% of gross primary agricultural and fishery products every year [4]. Improper smoking and drying of fishes may lead to insect infestation, fungal attack, fragmentation and degradation of the product [5. 6]

In Nigeria, there is an increase in the consumption of smoked fishes among the people. And some people testified that they do not eat foods that are preserved unnaturally due to health risk. Some chemical preservatives like table salt, brining, addition of sodium sorbate are commonly used for smoking of fish in which they may have adverse effect on human health but herbal preservatives have no effect and add to the flavor and seasoning for some foods and they also act as antimicrobial agents by killing microbes that present in the food.

Fish has been playing an important role in addressing nutritional and livelihood security of people in the developing countries. Fish provides 20% of animal protein intake to about 2.6 billion people globally and at least 50% of animal protein intake for over 400 million in Asia and Africa. But, in developed countries, it provides only 13% of animal protein intake [7]. To satisfy the consumer demand, it is necessary to produce good quality and safe smoked seafood products.

Fish microflora includes bacterial species such as *Pseudomonas*, *Alcaligenes*, *Vibrio*, *Serratia* and *Micrococcus* [8]. Microbial growth and metabolism is a major cause of fish spoilage which produce amines, biogenic amines such as putrescine, histamine and cadaverine, organic acids, sulphides, alcohols, aldehydes and ketones with unpleasant and unacceptable off-flavors [9,10,11].

For unpreserved fish, spoilage is a result of Gram-negative, fermentative bacteria (such as *Vibrionaceae*), whereas psychrotolerant Gram-negative bacteria (such as *Pseudomonas* spp. and *Shewanella* spp.) tend to spoil chilled fish [8]. The report by [12] stated that smoked fish samples from 4 local Markets in Kainji Lake area of Nigeria were dominated by gram-positive bacteria, potential pathogens, coagulase-positive Staphylococcus, and *Escherichia coli.*

Herbal preservatives also called natural preservatives are used in preserving food naturally. Some of these herbal preservatives consist of proteins, eugenol, gallic-acid, folate, tannis, vitamin B, vtamin C, vitamin E, vitamin K, choline and triterpene. Preservatives are substances, are either natural or synthetic that helps keep foods fresh looking and tasting longer and prevent them from deteriorating and rotting too quickly. Synthetic or artificial preservatives are used in processed and packaged foods sold in grocery and convenient stores for longer shelf-life [13].

Ginger (Zingiber officinale) is a flowering plant in the family Zingiberaceae whose rhizome, ginger root or simply ginger is widely used as spice or medicine. It is a herbaceous perennial which grows annual stems about a meter tall bearing narrow green leaves and yellow flowers. Ginger is indigenous to Southern China, and was spread eventually to the spice Island [14].

The objectives of this study were to evaluate the effect of ginger on the microbial, physical, organoleptic, nutritional quality and safety of smoked tilapia fish during 8-week storage at room temperature.

MATERIALS AND METHODS

Study Area: The study was carried out at Oyo state college of Agriculture and Technology which is located in Igboora, within 7^0.5 North and 3^0.30 east of the equator with an average annual rainfall of 1278mm and average annual temperature 27^0c [15].

Sample collection: Thirty kilogramme (30 kg) of fresh tilapia (*Oreochromis niloticus*) were purchased from Oyan dam in Ogun State of Nigeria. The samples were taken to the Department of Science Laboratory Technology of the Oyo State College of Agriculture and Technology, Igboora where the experiment was carried out. The natural Preservative (ginger) was bought at Towobowo local market in igboora, Oyo State.

Processing of natural preservatives: The ginger was milled to fine powder with the aid of a Binatone blender (Model BLG+10), sieved and weighed, then poured inside an air-tight container until ready for use. The samples were subjected to treatments where group 1, was not treated (control) and group 2 was mixed with 5g of ginger Mor salt. Smoking was done at fish farm processing unit of Oyo State College of Agriculture and Technology Igboora, according to the methods described by [16].

Microbiological Analysis: The samples were subjected to analysis after two, four, six and eight weeks of storage at a room temperature on total viable count (TVC), total coliform count (TCC) and fungi count according to the methods described by [17].

Proximate Composition of the samples

Moisture contents, fat contents, ash contents, Crude lipid, Crude fibre and Crude protein were estimated as per [18].

Sensory Evaluation

Sensory evaluation was carried out according to the method of [18]. In which a total number of 10 panelists, who were selected randomly, assessed the quality of the fish samples. The panelists were rated the samples on a scale ranging from 1-5 by using 5 point hedonic scale of (5=like much, 4=like, 3=neither like nor dislike, 2=dislike, 1=dislike much). The sensory qualities assessed were Colour/appearance , Flavour/Odour, Texture, Taste and Overall acceptability.

Statistical Analysis: The data generated from these investigations were analyzed using Statistical Package for Social Sciences (SPSS) version 20.0. And they were subjected to one way analysis of variance (ANOVA) and test for significance were carried out using Duncans multiple range tests.

RESULTS AND DISCUSSION

The results of the statistical analysis carried out on microbial plate counts of freshly and smoked fish samples are given in Table 1, the microorganisms isolated from each samples were presented in Table 2, the results of the sensory analysis of the samples were presented in Table 3 and the proximate composition of freshly untreated and treated smoked tilapia fish samples were presented in Table 4.

Table 1. Microbial load of smoked tilapia fish treated with group 1 and 2

WEEK 0	TVC (Cfu/g)	TFC (Cfu/g)	TCC (Cfu/g)
Untreated	7.5×10^3	9.5×10^3	5.5×10^3
Salt	9.0×10^3	6.1×10^3	3.1×10^4
Ginger	NG	6.5×10^3	NG
WEEK 2			
Untreated	2.5×10^4	5.5×10^6	4.2×10^5
Salt	NG	5.7×10^4	3.9×10^4
Ginger	2.4×10^3	4.3×10^4	2.0×10^3
WEEK 4			
Untreated	2.9×10^4	SPLT	SPLT
Salt	NG	1.4×10^5	NG
Ginger	5.5×10^3	5.0×10^4	NG
WEEK 6			
Untreated	SPLT	SPLT	SPLT
Salt	7.5×10^4	3.5×10^5	NG
Ginger	1.7×10^4	5.5×10^4	2.8×10^3
WEEK 8			
Untreated	SPLT	SPLT	SPLT
Salt	3.5×10^5	NG	NG
Ginger	NG	NG	NG

KEY: NG=No growth, TVC=Total viable count, TFC=Total fungi count, TCC=Total coliform count, SPLT= Spoilt

Table 2: Microorganisms isolated from freshly smoked tilapia fish samples

Fish sample	Microorganism (bacteria and fungi species)
Untreated	*Bacillus cereus, Klebssiella spp, Bacillus Subtilis, Proteus mirabilis, 4 bacteria + 4 fungi species Nigrospora spp, Aspergillus spp, Aspergillus flavus, penicillium spp*
Salt	*Bacillus cereus, Klebssiella spp,* 2 bacteria + 2 fungi, *Nigrospora spp, Aspergillus spp*
Ginger	*Bacillus subtilis, Proteus mirabilis, Klebssiella spp,* 3 bacteria + 2 fungi, *Aspergillus fumigatus, mucor*

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Table 3 shows the results of the sensory analysis of the samples.

Mean values of the organoleptic attributes of freshly treated and untreated smoked tilapia fish before storage

Fish samples	Colour	Flavour	Texture	Taste	Overall acceptability
Untreated (control)	3.5	3.8	4.1	3.7	2.1
Salted	4.8	4.1	4.3	4.7	4.5
Ginger	4.0	3.7	3.6	3.2	3.3

Mean values of the organoleptic attributes of untreated and treated smoked tilapia fish after storage for 2, 4, 6 and 8 week

Untreated (control)	2.0	1.7	1.3	1.0	1.7
Salted	4.1	4.3	3.8	3.3	3.7
Ginger	4.5	3.6	3.1	2.9	2.9

N.B Group 1 = sample untreated

Group 2 = sample mixed with salt/ginger

Table 4:- Determination of proximate composition of freshly untreated and treated smoked tilapia fish samples

Smoked tilapia fish Sample	%crude protein	%ash content	%fat content	%crude fibre	%dry matter	%moisture content
Untreated	20.32	17.08	4.54	1.79	65.17	75.11
Salt	62.96	19.17	5.80	0.90	73.21	26.79
Ginger	64.75	20.49	7.10	0.92	76.70	23.30

Microbial Load Counts of the Samples

As shown in **Table 1,** the numbers of microbial colonies formed by each sample was obtained. The microbial load varied significantly ($P < 0.05$) among the three samples (untreated/control, salt and ginger). TVC at fresh state of the samples, the salt sample recorded higher value of (9.0×10^3), followed by untreated sample of (7.5×10^3) and (zero/no growth) was recorded in ginger sample. In the second week, the TVC recorded higher value of (2.5×10^4) in untreated sample, followed by ginger sample of (2.4×10^3) while salt sample recorded (zero/no growth). In the fourth week, the TVC recorded higher value of (2.9×10^4) in untreated sample and ginger sample recorded (5.5×10^3) while salt sample recorded (zero/no growth). In the sixth week, the TVC recorded higher value of (7.5×10^4) in salt sample and ginger sample recorded (1.7×10^4) while untreated sample got spoilt at the sixth week of storage and count could not be made again. In the eighth week, the TVC recorded higher value of (3.5×10^5) in salt sample while (zero/no growth) was recorded in ginger sample and no record was recorded in untreated sample. The bacterial load (TVC) count results for all the samples used for this study are below the maximum bacteria count of 5×10^5 cfu for good fish product according to the

International Commission on Microbiology Safety for Food and it was shown that bacteria species were presented in all the samples (table 2). The results obtained were similar to those observed by [19].

The TFC at fresh state of the samples recorded higher value of (9.5×10^3) in untreated sample , followed by ginger and salt of (6.5×10^3)and(6.1×10^3) respectively. In the second week, the TFC recorded higher value of (5.5×10^6) in untreated sample, followed by salt and ginger sample of (5.1×10^4) and (4.3×10^4) respectively. In the fourth week, the TFC recorded higher value of (1.4×10^5) in salted sample, followed by ginger sample of (5.0×10^4) while untreated sample got spoilt at the week four of storage and the count could not be made again. In the sixth week, the TFC recorded higher value of (3.5×10^5) in salt sample, followed by ginger sample of (5.5×10^4) while no record was recorded in untreated sample. In the eighth week, zero/no growth was recorded in salt and ginger while no record was recorded in untreated sample. It shows that fungi species were presented in all the samples (table 2). The results obtained were similar to those observed by [20, 21].

The TCC at fresh state of the samples recorded higher value of (3.1×10^4) in salt sample and the least value of (5.5×10^3) in untreated sample, while (zero/no growth) was recorded in ginger sample. In the second week, the TCC recorded higher value of (4.2×10^5) in untreated sample and (3.9×10^4) was recorded in salt sample while ginger sample recorded (2.0×10^3). In fourth week, salt and ginger samples recorded (zero/no growth) while untreated sample got spoilt at the week four of storage and the count could not be made again. In sixth week, salt and ginger samples recorded (zero/no growth) and untreated sample, count could not be made again. In eighth week, all the samples recorded (zero/no growth) except untreated sample which have been spoilt at week four of storage. The increased in (TCC) of some fresh fish samples which later generally dropped significantly ($P < 0.05$) at the end of 8 weeks may be due to presence of water. The results were similar to those observed by [19].

In table 3, the quality of the smoked fish (both group 1 and 2) was evaluated immediately after smoking and after storage for 2nd, 4th, 6th and 8th week on colour, flavour, texture, taste and overall acceptability. The overall score was given to both (group 1 and 2) using a hedonic scale of 1- 5 where fish scoring less than 2.0 being regarded as unacceptable while above 2.0 being regarded as acceptable. Table 3 summarizes the taste panel results. From the result, the trend of scores, for the overall acceptability of freshly smoked tilapia fish was scored as follows: $2.1< 4.5 < 3.3= 5.0$ while on the 2nd, 4th, 6th and 8th week the trends were $1.7 < 3.7 < 2.9 = 5.0$. The results of all the treatments were above 2.0 shows that they are all acceptable by the consumers except the untreated sample which had value less than 2. These results were consistent to the work of [22].

In the table 4, it was shown that proximate composition was increased in crude protein, fat content, ash content and dry matter while there was a drastic moisture and crude fibre reduction of freshly smoked tilapia fish treated with group 1 and 2. These values fall within the range given by the earlier study of [23] which obtained the crude protein increased to 48.87, 49.40 and 64.90% after 15 h of smoke-drying at 50, 60 and 70°C, respectively. This result is in agreement with earlier studies [2, 24, 25, 26]which all observed that smoking/drying increases crude protein, crude lipid and ash content of fish and meat products. It is observed that protein contents increased with decrease in moisture content [2].

CONCLUSION AND RECOMMENDATION

Results of this study are significant because most of these natural preservatives are medicinal which have no effect and add to the flavor and seasoning for some foods and they also act as antimicrobial agents by killing microbes that present in the food. Salt may have little effects on human health and some patients are advised by their medical doctor to be mindful of their salt intake. This work shows that some natural preservatives can serve as substitute for salt in food preservation; it may be due to the effects of the preservatives effects which slow down autolysis of smoked fish samples and consequently slow down the protein break down. With the results of this work, it is recommended that ginger as a natural preservative used in this work can serve as replacement for salt.

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